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## CLINICAL REPORT

# Skin Problems of the Stump in Lower Limb Amputees: 1. A Clinical Study

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**Use of a prosthesis in lower limb amputees can lead to skin problems of the amputation stump. However, little is known about the epidemiology and type of problems experienced. We conducted a cross-sectional survey consisting of a questionnaire and a clinical assessment of the amputation stump. The aims of the study were to estimate the prevalence of skin problems of the amputation stump, to evaluate the impact of these skin problems and to evaluate differences between clinically observed skin problems and skin problems reported by the amputee. Participants ( $n=124$ ) were recruited from among lower limb amputees who visited an orthopaedic workshop. The prevalence of skin problems was 36%. Problems identified were: reduction in prosthesis use, and reduction in walking distance without a break. Significantly more skin problems were reported than observed ( $p=0.011$ ). Cold skin and excessive perspiration in particular were significantly more reported than observed. Key words: skin problems; lower limb amputees; questionnaire; sampling study.**

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Skin problems of the stump in lower limb amputees are observed frequently in clinical practice. These skin problems include mechanically-induced problems (e.g. epidermoid cysts, calluses, and verrucous hyperplasia), allergic reactions (e.g. stump oedema, eczema, allergic contact dermatitis, and rash), and bacterial or fungal infections (1, 2). However, epidemiological data concerning the incidence and prevalence of skin problems of the stump in lower limb amputees is limited (3).

In a previous study we assessed skin problems in lower limb amputees by means of a questionnaire. The main purpose of that study was to explore determinants for skin problems of the stump in lower limb amputees (4). Older age, male gender, and peripheral arterial disease and/or diabetes as reason for amputation were

determinants that decreased the odds of having a skin problem of the amputation stump; whereas smoking, use of anti-bacterial soap, and a high frequency of washing the stump increased the odds of having a skin problem of the amputation stump. Due to the design of this study (a cross-sectional survey by means of a postal questionnaire), it was not possible to verify the skin problems reported by the participants. The estimated prevalence of skin problems of the stump found in this study was 63% (95% confidence interval (CI), 60–67%) (4). This prevalence is in contrast to another study (based on a retrospective chart review) in which a prevalence of 41% (95% CI, 37–44%) was found in the study population. Amputation level, being employed, type of walking aid, and the absence of peripheral vascular disease (as co-morbidity) were identified as determinants that increased the odds of having a skin problem of the amputation stump (5).

However, concerning these found prevalences, both studies have their limitations in study methodology (in both studies skin problems were not clinically assessed) (4, 5).

The main goal of this study was therefore to estimate the prevalence of skin problems of the stump in lower limb amputees by means of a clinical assessment, and to evaluate the influence of skin problems of the stump on prosthesis use, activity level and hygiene. Additional aims of this study were to evaluate differences between observed skin problems and reported skin problems assessed by a questionnaire, and to identify determinants of skin problems in lower limb amputees.

## MATERIALS AND METHODS

Participants were recruited from among lower limb amputees who visited an orthopaedic workshop (OIM, Haren, The Netherlands), for reasons related to their prosthesis (e.g. damage to the prosthesis, fitting problems, or starting a procedure for a new prosthesis) or due to a problem with the amputation stump. This orthopaedic workshop has affiliations with a university department of rehabilitation medicine, including a clinical rehabilitation ward for lower limb amputees. Lower limb amputees were included if they had an amputation at the transtibial level or more proximally, or a similar congenital lower limb deficiency, if they had more than 3 months experience with a prosthesis, and were at least 18 years of age. Excluded were amputees with inadequate knowledge of the Dutch language to complete a questionnaire, and with cognitive problems that interfered with answering a questionnaire. During

their visit to the orthopaedic workshop lower limb amputees were invited to participate in the study. After giving informed consent, participants were asked to complete a questionnaire; either during their visit to the workshop or at home (when the latter option was applicable, lower limb amputees were provided with a pre-paid return envelope). To optimize the response rate and precision of the questionnaire, participants were encouraged to complete the questionnaire during their visit to the workshop. The amputation stump was visually assessed by a physician (HM) for skin problems. The questionnaire used in this study consisted of a series of open and multiple-choice questions, based on excerpts from a previous questionnaire used in the literature, since no questionnaire was available. The questionnaire was designed to assess skin problems of the stump and identify determinants of these skin problems. This questionnaire has been used in a previous study without knowledge concerning its validity and reliability (4). The decision to use this questionnaire in this study made the comparison with results from previous research easier. In addition, there is no similar questionnaire to assess these determinants available (as far as we know) in the literature. The determinants assessed in this questionnaire were grouped into patient characteristics, amputation- and prosthesis-related characteristics, activity level of the amputee, and hygiene of the prosthesis and the amputation stump. In contrast to the original questionnaire, items were added to obtain more information on activity level of the participant, and to evaluate the impact of a skin problem of the stump on prosthesis use, activity level and hygiene. Participants could report present skin problems by a list of criteria that was part of the questionnaire. The physician used the same list to report his observation of a participant. The reports were made separately to prevent bias.

When a lower limb amputee did not want to participate, gender and date of birth were registered.

After assessment of the study protocol, the local medical ethics committee concluded that no formal permission was needed to conduct the study.

#### Data entry

The questionnaire data were entered into a database. If a participant was not able to complete the exact date of amputation, the following procedure was carried out. If the day of the month was missing, the 15<sup>th</sup> of that month was entered as the date of amputation. If the month was missing, the first of July of that year was entered as the date of amputation. All participants were able to report at least the year of amputation. This procedure was performed to calculate an accurate time since amputation, which was a determinant assessed by the questionnaire. Eight participants reported two reasons for amputation (peripheral arterial disease and diabetes). Because of the similarity in pathophysiology both reasons were entered as one reason for amputation (peripheral arterial disease and/or diabetes) in the database.

Regarding the participants who reported having a bilateral amputation ( $n=9$ ), the following procedure was followed. It was first verified on which side skin problems were reported most frequently. That side and level of amputation were used for statistical analysis ( $n=6$ ). When skin problems were reported on both sides, one side was randomly chosen for the analysis ( $n=1$ ). When level of amputation was not similar, and no skin problems were reported, a side was randomly chosen for the statistical analysis ( $n=2$ ).

#### Statistical analysis

Statistical analysis was performed using SPSS 16.0. Parametric and non-parametric tests were used to analyse the differences between participants and non-participants. Wilcoxon signed-rank tests were performed to analyse changes in prosthesis use, activity level, and hygiene due to a skin problem of the amputation stump. Wilcoxon

signed-rank test (since data was not normally distributed) was also performed to analyse differences between the total number of observed and reported skin problems. McNemar tests were used to analyse (for all possible skin problems that could be observed or reported) the difference between the number of observed and reported skin problems of the amputation stump. To forestall the effect of multiple testing concerning these McNemar tests, a Bonferroni correction was performed ( $\alpha=0.0042$ ) in these tests.

To identify determinants associated with reported skin problems, associations between determinants and a reported skin problem were explored by means of  $\chi^2$  analysis for dichotomous or ordinal data, and independent sample *t*-test for interval data.

## RESULTS

Over a period of 6 months 146 unique visitors attended the workshop. Five visitors stated they did not want to participate, while 17 initially agreed to participate, but did not complete the questionnaire. This resulted in 124 questionnaires and observations of the amputation stump, which were available for the statistical analysis after data entry (a response rate of 85%). The reason for the visit to the workshop ( $n=124$ ) was either related to the prosthesis ( $n=91$  (74%)), related to complaints of the amputation stump ( $n=10$  (8%)), related to a combination of stump problems and the prosthesis  $n=19$  (15%)) or related to other reasons ( $n=4$  (3%)). Participants were significantly older (mean 60 years  $\pm$  16 SD) than non-participants (mean 52 years  $\pm$  16 SD) ( $p<0.05$ ). Sex distribution did not differ significantly between participants (71% men) and non-participants (73% men). Table I presents descriptive statistics of the group of participants.

The most common level of amputation was transtibial (54%). The most common reason for amputation was peripheral arterial disease and/or diabetes (37%). Most of the participants had a maximal walking distance of less than 500 m (63%), and walked less than 500 m/day (63%). A majority used a liner in their prosthesis (61%). In Table II, observed and reported skin problems are presented.

In 42 amputees (34%; 95% CI 28–40%) one or more skin problems were observed, whereas 44 amputees (36%; 95% CI: 30–43%) reported one or more skin problems. This difference in number of participants was not significant ( $p=0.845$ ).

Analysis of the difference between the number of observed and reported skin problems (by means of a Wilcoxon signed-rank test) resulted in a significant difference ( $p=0.011$ ). The median number of skin problems was in both groups 0, with  $T=269$ , and effect size=0.23.

When repeating the analysis by using the participants in which at least one skin problem was observed or reported ( $n=57$ ) thereby excluding the participants without a skin problem, the median number of skin problems was in both groups 1,  $T=269$ , and effect size=0.33.

When the number of observed and reported skin problems was calculated while excluding presence of a cold skin and or excessive perspiration as a skin problem the

Table I. Demographics of participants

	Reported skin problems ( <i>n</i> = 44)	No reported skin problems <sup>a</sup> ( <i>n</i> = 80)
Age, years, mean ± SD	58 ± 17	61 ± 15
Time since amputation, years, mean ± SD	19 ± 18	15 ± 17
Sex, <i>n</i> (%)		
Men	32 (73)	56 (70)
Women	12 (27)	24 (30)
Amputation level, <i>n</i> (%)		
Transfemoral	25 (57)	41 (51)
Knee exarticulation	11 (25)	14 (17)
Transfemoral	7 (16)	22 (28)
Hip/pelvis	1 (2)	3 (4)
Bilateral	4 (9)	5 (6)
Reason for amputation, <i>n</i> (%)		
Peripheral arterial disease and/or diabetes	13 (30)	33 (41)
Trauma	15 (34)	28 (34)
Oncology	6 (13)	10 (13)
Congenital	3 (7)	3 (4)
Infection	4 (9)	6 (8)
Other	3 (7)	0 (0)
Comorbidity	21 (48)	40 (50)
Smoking	13 (30)	20 (26)
Employment	15 (34)	21 (26)
Walking aids	27 (61)	44 (55)
Walking distance without break, m, <i>n</i> (%)		
0–49	10 (23)	13 (16)
50–99	5 (11)	12 (15)
100–199	5 (11)	9 (11)
200–499	7 (16)	16 (21)
500–999	7 (16)	9 (11)
≥ 1000	10 (23)	21 (26)
Walking distance total, m/day, <i>n</i> (%)		
0–99	14 (32)	22 (28)
100–199	4 (9)	13 (16)
200–499	11 (25)	14 (18)
500–999	5 (11)	12 (15)
≥ 1000	10 (23)	19 (23)
Use of liner, <i>n</i> (%)	28 (64)	48 (60)
Sports with prosthesis, <i>n</i> (%)	11 (25)	16 (20)
Frequency washing stump, times/week, <i>n</i> (%)		
0–4	10 (23)	23 (29)
≥ 4	34 (77)	57 (71)
% use of prosthesis indoors, <i>n</i> (%)		
0–49	15 (34)	22 (26)
50–100	29 (66)	58 (74)
Hours a day prosthesis is worn, <i>n</i> (%)		
0–8	9 (21)	20 (25)
≥ 8	35 (79)	60 (75)
Skin problems in past <sup>c</sup> , <i>n</i> (%)	40 (90)	40 (50)

<sup>a</sup>At the time of completing the questionnaire.<sup>b</sup>Percentages are column percentages.<sup>c</sup>In period before completing the questionnaire.

SD: standard deviation.

difference between observed and reported skin problems in both analyses was no longer significant ( $p = 0.246$ ).

Some examples of skin problems of the stump present at presentation of participants are shown in Fig. 1.

When analysing the changes in prosthesis use, walking distance, and washing frequency in the group of participants who reported a skin problem on the amputation stump ( $n = 44$ ), 22 participants (50%) had a reduction in prosthesis use, and 24 participants (54%)

Table II. Number of observed and reported skin problems of the stump

Skin problems <sup>a</sup>	Observed <i>n</i> (%) <sup>b</sup>	Reported <i>n</i> (%) <sup>b</sup>	Significance
Excessive perspiration	2 (2)	11 (9)	0.0040 <sup>c</sup>
Cold skin	2 (2)	15 (12)	<0.001 <sup>c</sup>
Warm skin	0 (0)	4 (3)	0.125
Redness more than 1 min after doffing	28 (23)	21 (17)	0.167
White skin	0 (0)	6 (5)	0.031
Swelling	5 (4)	8 (6)	0.453
Pimple	8 (6)	11 (9)	0.549
Blister	2 (2)	9 (7)	0.016
Crust	2 (2)	3 (2)	1.000
Corn/callus	12 (10)	13 (10)	1.000
Abrasion	14 (11)	13 (10)	1.000
Existing wound	9 (7)	4 (3)	0.125
No. of skin problems, mean ± SD	0.69 ± 1.0	0.96 ± 1.7	0.009

<sup>a</sup>A participant could claim more than one skin problem.<sup>b</sup>Percentage is of the total number of participants ( $n = 124$ ).<sup>c</sup>Significant after Bonferroni correction ( $\alpha = 0.0042$ ).

SD: standard deviation.

had a reduction in walking distance without a break. In addition, three participants (7%) indicated that they used another product for cleaning the stump due to the skin problem. Fourteen participants (32%) reported that they used some kind of protection (e.g. a patch) with the aim to prevent aggravation of the skin problem. Twenty participants stated that, in their opinion, the prosthesis was the cause for the presence of the skin problem.

Concerning the occurrence of skin problems of the stump in the period prior to the participation in this study, 80 participants (66%: 95% confidence interval (CI) 54–77%) reported to have endured one or more skin problems in the past. The most frequently occurring skin problems were pressure ulcer (39%) and infection (25%). In addition, 42 participants (53%: 95% CI 41–64%) reported that skin problems endured in the past had resulted in a reduction in the time the prosthesis could be worn. Statistical analysis of the relationship between the presence of a skin problem and one or more of the investigated determinants (patient characteristics, amputation- and prosthesis-related characteristics, activity level of the amputee, and hygiene of the prosthesis and the amputation stump) had as a result that no significant relationship could be identified. Therefore no additional analysis was performed.

## DISCUSSION

The prevalence of skin problems in this study (using the number of skin problems reported by the participants) was 36% (95% CI: 30–43%). Previously reported prevalences in literature concerning skin problems of the stump in lower limb amputees are summarized in Table III.

When comparing the prevalences previously reported with the prevalence found in this study it is in agreement



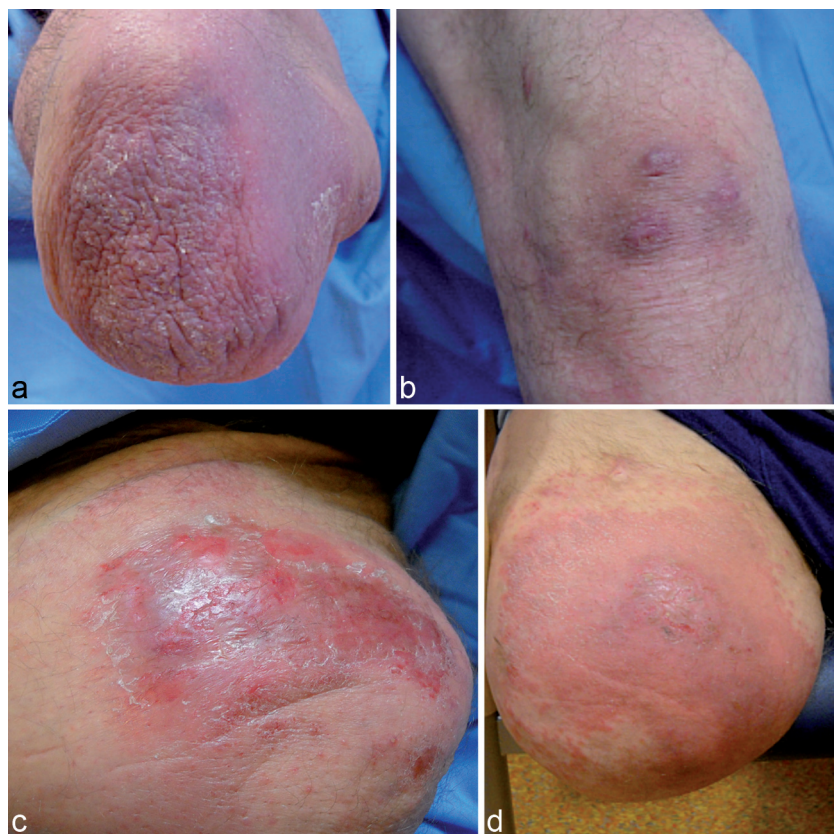


Fig. 1. Examples of skin problems present on the amputation stump of participants. (a) Corn on the distal part of the stump (in this case pachydermia) in a transtibial amputee. (b) Pimples (in this case, folliculitis) in the patellar region in a transtibial amputee. (c) Abrasion in a transfemoral amputee. (d) Redness > 1 min after doffing the prosthesis (in this case due to a fungal infection) in a transfemoral amputee.

with two other clinical studies (1, 6), which assessed skin problems of the stump in lower limb amputees, and with a study based on a retrospective chart review (5).

The differences in the other reported prevalences may be due to research setting, type of study, and the gender and/or age distribution of the study population.

The prevalence found in the current study is in contrast with the prevalence found in our previous study (a cross-sectional survey by means of a questionnaire). In that study a prevalence of 63% (95% CI: 60–67%) was found (4). The difference between the found prevalences in the previous study compared with the current study may be explained by the study method and differences in study population. There may be an overestimation of the prevalence in our previous study due to selection bias. It can be assumed that lower limb amputees with a skin problem were more likely to participate. Additionally, the time window in which lower limb amputees could report a skin problem was one month in the previous study (compared with the presence of a skin problem on participation in the current study), which also may have resulted in an overestimation of the prevalence. This explanation is supported by the percentage of amputees in the current study who reported having had at least one skin problem in the past (66%; 95% CI 54–77%).

Concerning the study populations, there was no difference in the mean age of the participants in both studies ( $p=0.86$ ), but a larger proportion of males (71%) participated in the current study compared with the percentage of males in the previous study (62%). Since male gender is a determinant identified as decreasing the odds of having a skin problem, this may also be an explanation of the difference in prevalences between the studies.

Table III. Overview of literature concerning prevalence of skin problems in lower limb amputees. Studies were entered in this table if they provided prevalence data of skin problems in lower limb amputees, based on physical examination or chart review, or questionnaire specifically assessing skin problems. Studies considering only one specific type of skin problem were not entered in the table

First author, year (reference)	Type of study	<i>n</i>	Age, years, mean $\pm$ SD	Gender (M/F) <i>n</i>	Prevalence % (95% CI)
DesGroseilliers <sup>a</sup> , 1978 (6)	PE	48	NA	NA	30 (19–44)
Chan, 1990 (7)	Q/PE	47	75.4	21/26	15 (12–23)
Pohjolainen <sup>b</sup> , 1991 (8)	PE	124	62.8	112/43 <sup>b</sup>	7 (6–10)
Lyon <sup>c</sup> , 2000 (1)	Q/PE	210	52.6	52/19 <sup>c</sup>	34 (28–40)
Dillingham, 2001 (9)	CR/I	78	NA	68/10	24 (16–33)
Dudek <sup>d</sup> , 2005 (5)	CR	745	58.3 $\pm$ 16.7	634/111	41 (37–44)
Koc, 2008 (2)	PE	142	29.2 $\pm$ 9.7	139/3	74 (61–85)
Meulenbelt, 2009 (4)	Q	805	60 $\pm$ 15	498/307	63 (60–67)

<sup>a</sup>Only sample size and number of participants with complaints ( $n=15$ ) was reported.

<sup>b</sup>Only data of initial group present ( $n=155$ ).

<sup>c</sup>Only data from participants with complaints ( $n=71$ ).

<sup>d</sup>Skin complaints researched per leg, bilateral amputees counted twice.

NA: not available in publication; PE: physical examination; Q: questionnaire; CR: chart review; I: interview; CI: confidence interval; SD: standard deviation; M/F: male/female.

Considering the presence of a skin problem at the patient level, there was no significant difference between participant and physician in the number of participants who had a skin problem. There was a significant, but very small, difference between the numbers of skin complaints observed and reported (less than 0.3); the physician observed fewer skin complaints than the participants. When considering the individual complaints that could be reported, especially for skin problems based on physical complaints (corn, crusts, and abrasion) there was a good level of agreement. A significant disagreement was found for cold skin and excessive perspiration, which were reported more by participants than was observed by the physician. An explanation for this difference may be that these complaints can differ in presentation over the day, and may be underestimated or missed at the time that participants were assessed by the physician.

When evaluating the impact of a skin problem on activity level, prosthesis use, and hygiene, only walking distance without a break decreased significantly as a result of skin problems. However, this may be a false positive result, since multiple statistical tests were performed on a small study sample. In contrast with our previous research no associations were found between the determinants investigated and a skin problem of the stump (4). This result might be explained by the smaller sample size of the current study, the time window that was used in the current study, or by differences in characteristics between the study populations (especially the percentage of male gender). Other differences between both study populations were the liner use in a prosthesis (61%, compared with 50% in the previous study) and the time the prosthesis is worn over the day (77% of the current study population wears the prosthesis  $\geq 8$  h/day, compared with 84% in the previous study). However, these determinants were not identified influencing skin problems in our previous study (4).

### Limitations

We are not certain whether our current study sample resembles the general population of lower limb amputees in the Netherlands. Since the orthopaedic workshop where participants were recruited has an affiliation with a university department of rehabilitation medicine, this may influence the participant characteristics. In contrast with our previous study, participants were significantly older than non-participants. However, only 43% of the current participants were over 65 years of age, while 79% of the patients who undergo a lower limb amputation are over 65 years of age (10). The reason for amputation in our study population differs from the general population of lower limb amputees in the Netherlands. In this study 37% had undergone a lower

limb amputation due to peripheral arterial disease and/or diabetes, compared with 94% in the general population (10). However, the actual percentage of lower limb amputees who use a prosthesis and had their amputation due to peripheral arterial disease and/or diabetes will be much lower than 94%, since the life expectancy of these lower limb amputees is limited (11). In addition, approximately 50% of this group of lower limb amputees will eventually get a prosthesis (10).

### Conclusions

The prevalence of skin problems of the stump in lower limb amputees was estimated as 36%. Skin problems result in a reduction in walking distance without a break and a reduction in prosthesis use. There was disagreement on the number of skin complaints between physician and participant. Cold skin and excessive perspiration were significantly more frequently reported than observed. No determinants of skin problems in lower limb amputees could be identified in this study.

*The authors declare no conflicts of interest.*

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